PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 501758 GWW	FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/NZ2004/000133	International filing date *(day/month/year)* 24 June 2004	Priority date *(day/month/year)* 24 June 2003
International Patent Classification (IPC) or national classification and IPC **Int. Cl.** [7] F26B 3/20, 15/00, 17/00		
Applicant CARRINGTON, Cedric Gerald et al		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 3 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. [X] *(sent to the applicant and to the International Bureau)* a total of **6** sheets, as follows:
      - [X] sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      - [ ] sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

   b. [ ] *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or table related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).
4. This report contains indications relating to the following items:

[X]	Box No. I	Basis of the report
[ ]	Box No. II	Priority
[ ]	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
[ ]	Box No. IV	Lack of unity of invention
[X]	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
[ ]	Box No. VI	Certain documents cited
[ ]	Box No. VII	Certain defects in the international application
[ ]	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of the report
21 April 2005	7 June 2005
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer **GREGORY DIVEN** Telephone No. (02) 6283 2992

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/NZ2004/000133

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:

   ☐ international search (under Rules 12.3 and 23.1 (b))

   ☐ publication of the international application (under Rule 12.4)

   ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

   ☐ the international application as originally filed/furnished

   ☒ the description:

   pages **1-3, 5-13** as originally filed/furnished
   pages* received by this Authority on with the letter of
   pages* **4** received by this Authority on **21 April 2005** with the letter of **21 April 2005**

   ☒ the claims:

   pages as originally filed/furnished
   pages* as amended (together with any statement) under Article 19
   pages* **14-18** received by this Authority on **21 April 2005** with the letter of **21 April 2005**
   pages* received by this Authority on with the letter of

   ☒ the drawings:

   pages **1-3** as originally filed/furnished
   pages* received by this Authority on with the letter of
   pages* received by this Authority on with the letter of

   ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

   ☐ the description, pages
   ☐ the claims, Nos.
   ☐ the drawings, sheets/figs
   ☐ the sequence listing (*specify*):
   ☐ any table(s) related to the sequence listing (*specify*):

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

   ☐ the description, pages
   ☐ the claims, Nos.
   ☐ the drawings, sheets/figs
   ☐ the sequence listing (*specify*):
   ☐ any table(s) related to the sequence listing (*specify*):

* *If item 4 applies, some or all of those sheets may be marked "superseded."*

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/NZ2004/000133

Box No. V **Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims **1-26**	**YES**
	Claims	**NO**
Inventive step (IS)	Claims **1-26**	**YES**
	Claims	**NO**
Industrial applicability (IA)	Claims **1-26**	**YES**
	Claims	**NO**

2. Citations and explanations (Rule 70.7)

SU 901778

US 4646447

JP 59-014758

JP 81-78522

Novelty (N) and Inventive Step (IS)

The invention defined in amended claims 1-26 are novel and involve an inventive step when compared to the above citations which are considered the closest prior art.

None of the citations reveal the primary source of drying heat being provided by conduction and/or convection with this heat being obtained through the use of a heat exchanger to cool and dry the drying gas. The normal method of drying previously has involved drying the gas through heating the gas prior to passing it through the drying chamber or alternately using a direct source of heat such as microwave or infra red lamps which requires a significant input of energy compared to a system where a lot of the heat is recycled.

Industrial Applicability (IA)

The claims are related to products capable of commercial application.

conveyors. However, the high fan power costs associated with moving the large amounts of drying gas required will leave it with a cost and efficiency disadvantage.

Thus, although there have been numerous attempts to improve the efficiency and effectiveness of drying pastes, liquors and aggregate materials, there is still opportunity for further improvements.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an improved drying process and/or an apparatus for drying by means of a heat integrated and/or heat pumping process and/or apparatus.

In one aspect the present invention may be said to consist of a heat pump or heat integrated apparatus operable in a drying apparatus with the heat pump evaporator or cold heat exchanger in primary thermal contact for convective and/or conductive heat exchange with the drying gas medium after said drying gas medium has taken up moisture from the material being dried and the heat pump condenser or hot heat exchanger in primary thermal contact for convective and/or conductive heat exchange with the material being dried and with both the drying gas medium and any heat pump refrigerant in nominally closed loop circulation paths.

In another aspect the present invention may be said to consist of a heat pump and drying apparatus including a drying chamber and a heat exchange apparatus, wherein the heat exchange apparatus includes a colder heat pump evaporator or heat integrated heat exchanger(s) and a hotter heat pump condenser or heat integrated heat exchanger(s) arranged such that during operation, the colder heat exchanger(s) substantially exchanges heat with the moisture rich drying gas stream, and the hotter heat exchanger(s) substantially exchanges heat with the material being dried rather than the moisture lean drying gas stream.

CLAIMS:

1. A heat exchange system for a drying apparatus including:

a drying gas to remove moisture from the material being dried, and

a heat source heat exchanger containing a heat source medium to heat the material being dried primarily by conduction and/or convection configured in such a way that the majority of heat transferred to the material being dried does not first pass through the drying gas stream so the drying gas stream primarily carries moisture away from the material being dried but does not carry the majority of heat into the material being dried, and

a heat sink heat exchanger containing a heat sink medium to cool and condense liquid out of a drying gas.

2. A heat exchange system according to claim 1 where at least part of the heat sink heat exchanger is an evaporator in a heat pump system.

3. A heat exchange system according to claim 2 where at least part of the heat source heat exchanger is a condenser in a heat pump system.

4. A heat exchange system according to any one of claims 1 to 3 with the heat source heat exchanger configured such that the heat is distributed from the heat source medium through a fixed heat conduction medium and then into the material being dried.

5. A heat exchange system according to claim 4 where the fixed heat conduction medium is a thermally conducting plate with internal passages through which the heat source material flows.

6. A heat exchange system according to claims 4 or 5 where the material being dried is moved across the fixed heat conduction medium on a moving belt in thermal contact with the fixed heat conduction medium.

7. A heat exchange system according to claims 4 or 5 where the material being dried is spread over the fixed heat conduction medium and then removed after releasing some of its moisture to the drying gas.

8. A heat exchange system according to any one of claims 1 to 7 arranged to operate with the drying gas at a temperature between 25 and 90C.

9. A heat exchange system according to any one of claims 1 to 8 including means for rejecting heat from the drying apparatus to the external environment such as full time or periodic drying gas venting, pre-cooling the drying gas entering the evaporator, pre-cooling any make-up or purge drying gas entering or leaving the apparatus, sub-cooling the liquid heat pump refrigerant after it leaves the condenser and before it enters the evaporator, de-superheating the heat pump refrigerant leaving the compressor, or partially or wholly condensing the high-pressure refrigerant for purposes of control.

10. A heat sink exchange system according to any one of claims 1 to 9 arranged so that the drying gas passes over a substantially closed loop path repeatedly through the heat exchange system and past or through a drying zone containing a material to be dried.

11. A drying apparatus including:

a drying chamber where material is dried,

a drying gas to remove moisture from the material being dried, and

a heat source heat exchanger containing a heat source medium to heat the material being dried primarily by convection and/or conduction configured in such a way that the majority of heat transferred to the material being dried does not first pass through the drying gas stream so the drying gas stream primarily carries moisture away from the material being dried but does not carry the majority of heat into the material being dried, and

a heat sink heat exchanger containing a heat sink medium to cool and condense liquid out of a drying gas.

12. A heat pump for a drying apparatus including:

a condenser to heat the material being dried primarily by convention and/or conduction configured in such a way that the majority of heat transferred to the material being dried does not first pass through the drying gas stream so the drying gas stream primarily carries moisture away from the material being dried but does not carry the majority of majority of heat into the material being dried, and

an evaporator to cool and condense liquid out of a drying gas.

13. A heat exchange apparatus operable in a drying apparatus including:

a hot heat exchanger to heat the material being dried primarily by convection and/or conduction configured in such a way that the majority of heat transferred to the material being dried does not first pass through a drying gas stream so the drying gas stream primarily carries moisture away from the material being dried but does not carry the majority of heat into the material being dried, and

a cold heat exchanger to cool and condense liquid out of a drying gas.

14. A process for drying a material including:

causing a drying gas to remove moisture from the material being dried, and

heating the material being dried primarily by convection and/or conduction with a heat source heat exchanger containing a heat source medium where the majority of heat transferred to the material being dried does not first pass through the drying gas stream so the drying gas stream primarily carries moisture away from the material being dried but does not carry the majority of heat into the material being dried, and

cooling and condensing liquid out of a drying gas with a heat sink heat exchanger containing a heat sink medium and a heat sink heat transfer surface.

15. A drying process according to claim 14 wherein at least part of the heat sink heat exchanger is an evaporator in a heat pump system.

16. A drying process according to claim 15 wherein at least part of the heat source heat exchanger is a condenser in a heat pump system.

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17. A drying process according to any one of claims 14 to 16 with the heat source heat exchange configured such that the heat is distributed from the heat source medium through a fixed heat conduction medium and then into the material being dried.

18. A drying process according to claim 17 where the fixed heat conduction medium is a thermally conducting plate with internal passages through which the heat source material flows.

19. A drying process according to claims 17 or 18 where the material being dried is moved across the fixed heat conduction medium on a moving belt in thermal contact with the fixed heat conduction medium.

20. A drying process according to claims 17 or 18 where the material being dried is spread over the fixed heat conduction medium and then removed after releasing some of its moisture to the drying gas.

21. A drying process according to any one of claims 14 to 20 including operation with the drying gas at a temperature between 25 and 90C.

22. A drying process according to any one of claims 14 to 21 including rejecting heat from the drying apparatus to the external environment such as full time or periodic drying gas venting, pre-cooling the drying gas entering the evaporator, pre-cooling any make-up or purge drying gas entering or leaving the apparatus, sub-cooling the liquid heat pump refrigerant after it leaves the condenser and before it enters the evaporator, de-superheating the heat pump refrigerant leaving the compressor, or partially or wholly condensing the high-pressure refrigerant for purposes of control.

23. A drying process according to any one of claims 14 to 22 arranging the drying gas to pass over a substantially closed loop path repeatedly through the heat exchange system and past or through a drying chamber for containing a material to be dried.

24. A heat pump apparatus operable in a drying apparatus with the heat pump evaporator in primary thermal contact with a drying gas medium after said drying gas medium has taken up moisture from the material being dried and the heat pump condenser in primary thermal contact with the material being dried and with both the drying gas medium and the heat pump refrigerant in nominally closed loop circulation paths.

25. A heat pump and drying apparatus including a drying chamber, a heat exchange apparatus and a drying gas stream, wherein the heat exchange apparatus includes a colder heat pump evaporator heat exchanger and a hotter heat pump condenser heat exchanger arranged such that during operation, the colder evaporator heat exchanger substantially exchanges heat with the moisture rich drying gas stream, and the hotter condenser heat exchanger substantially exchanges heat with the material being dried primarily by convection and/or conduction rather than the moisture lean drying gas stream.

26. A heat pump driven drying process with a drying gas stream, wherein the heat exchange is performed though a colder heat pump evaporator heat exchanger and a hotter heat pump condenser heat exchanger arranged such that during operation, the colder evaporator heat is exchanged substantially with the moisture rich drying gas stream, and the hotter condenser heat is exchanged substantially with the material being dried primarily by convection and/or conduction rather than the moisture lean drying gas stream.